THE MULTIPLE DISCHARGE-SERVO CURVE CONTROL METHOD AND DEVICE OF ELECTRICAL DISCHARGE MACHINE

BACKGROUND OF INVENTION

1. Field of Invention

This invention mainly develops the multiple discharge-servo curve control method and device of electrical discharge machine. Especially, it means a numerical control method used by the electrical discharge machine, herein it will choose multiple discharge servo curves by calling the discharge servo curve instruction during the machining process. This application can be used for the electrical discharge machine, the drilling electrical discharge machine and the wire-cut electrical discharge machine.

2. Description of The Prior Art

Electrical Discharge Machine (EDM) adopts the sparking generated between the electrode and workpiece, and then melts as well as evaporates the material, under a locally instant high temperature condition, to achieve the cutting result, which is a non-traditional machining technology. Since EDM has already been adopted to treat a more complex and higher precision product by the industries worldwide, but the precision control technique of EDM is still not good enough and needs to be improved indeed.

The gap-voltage control-loop of the electrical discharge machine will determine the suitable cutting speed by the real measurement of the moving and the calculating the deviation of the gap-voltage.

Moreover, Figure 1 shows the functional block diagram of a known gap-voltage control loop of the electrical discharge machine, wherein it will calculate the gap-voltage difference between the real measurement and the operator inputs, and then outputs the cutting speed after the outcomes are processed through the multiple discharge-servo curve controller and the deviation controller. Furthermore, the positioning control-loop guides the electrical discharge machine to work on the cutting with a position command integrated by the integrator. Finally, it will issue a real gap dimension for calculating the gap deviation by subtracting that real gap dimension with an original operator-input gap value, and calculates the gap-voltage by the gap and the gap-voltage converter, and then subtracts that gap-voltage with the referred operator-input gap-voltage. Recursively, the next gap-voltage control cycle goes on, wherein the cutting speed corresponded to the gap-voltage deviation, which is calculated by the internally used gap-voltage deviation and cutting speed control curve of the multiple discharge-servo curve controller. The gap-voltage deviation and the cutting speed control curve are generally called as a discharge-servo curve. As shown in the Figure 2, the discharge-servo curve is built on the relationship of the gap-voltage deviation and the cutting speed, and contains a nonlinear discharge-servo curve 1a and a linear discharge-servo curve 1b.

The multiple discharge-servo curve controller of electrical discharge machine chooses a discharge-servo curve by the control

software device of known electrical discharge machine software structure as shown in Figure 3, and then that flowchart of known discharge-servo curve control method is shown in Figure 4. Before initiate the program, the discharge-servo curve is set on the CNC control panel and the discharge-servo curve data is recorded inside the multiple discharge-servo curve controller, and then cutting process goes on following with the discharge-servo curve data which is recorded inside the multiple discharge-servo curve controller as soon as the program started.

The required cutting speed is different during the workpiece cutting process, which dues to the different machining environment such as a different material of electrode, workpiece, cutting solution, coarse or fine process. If the known discharge-servo curve control method is adopted, the executing program has to be stopped in order to exchange a discharge-servo curve data, and then backs to set the discharge-servo curve on the CNC control panel for swapping the record inside the multiple discharge-servo curve controller and the discharge-servo curve data. Therefore, it is really not convenient to the case of single workpiece with multiple discharge-servo curves.

Conclusively, how to allow an electrical discharge machine arbitrarily choosing the discharge-servo curve during the real cutting process is sincerely a problem.

SUMMARY OF THE INVENTION

The main purpose of this invention can lead to solve the aforesaid defects. Adopt the program calling, this invented multiple

discharge-servo curve control method and device of electrical discharge machine will allow the operator to swap the different discharge servo curve in according with the real process requirement during the electrical discharge machine working and to achieve the one-step process with arbitrarily choosing the multiple discharge-servo curve.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a functional block diagram of a known gap-voltage control loop of the electrical discharge machine.

FIG. 2 is a plot of the discharge-servo curve.

FIG. 3 is a configuration of known electrical discharge machine software structure.

FIG. 4 is a flowchart of known discharge-servo curve control method.

FIG. 5 is a flowchart of this invented multiple discharge-servo curve control method of electrical discharge machine.

FIG. 6 is a hierarchy of this invented control software structure.

FIG. 7 is a configuration of this invented multiple discharge-servo curve control device of electrical discharge machine.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

This invention is the multiple discharge-servo curve control method and device of electrical discharge machine; the flowchart of this invented multiple discharge-servo curve control method shown in

Figure 5. Primarily set the discharge-servo curve database 11 whenever the beginning 10 command is issued, wherein each gap-voltage deviation and its corresponded cutting speed of the discharge-servo curve are input from the CNC control panel in order to set up the multiple discharge-servo curve database. The algorithm of the discharge-servo curve is constructed on the records of the gap-voltage deviation and the cutting speed that is under the real optimal processing condition. Moreover, correlated it with the collected gap-voltage deviation and its cutting speed that are under the different electrode material, different workpiece material, and different cutting solution. A polynomial equation is expressed with those gap-voltage deviations and its corresponded cutting speeds as:

$$f(e) = a_0 + a_1 \times e + a_2 \times e^2 + a_3 \times e^3 + a_4 \times e^4 + \Lambda + a_n \times e^n$$

where $f(e)$ is the cutting speed and e is gap-voltage deviation. The aforesaid polynomial equation is called as the discharge-servo curve equation, and it is used to set up the discharge-servo curve with lots of different processing conditions. Moreover, defining the discharge-servo curve parameter 12 is first set in the discharge-servo curve database to correspond a numerical value of the discharge-servo curve parameter; such as the 1st discharge-servo curve corresponds to a numerical value of the discharge-servo curve parameter that is set as "1" in the discharge-servo curve database, and then set that discharge-servo curve parameter's value to be that discharge-servo curve according to the discharge-servo curve required under process environment. After all read the initial

discharge-servo curve data 13, which is based on the discharge-servo curve parameter's value, then read its corresponded discharge-servo curve data from the discharge servo curve database and record it into the multiple discharge-servo curve controller. Input the processing program 14 after set and read the discharge-servo curve data for the machining required, which is using the CNC control panel to key in the working instruction and the discharge-servo curve instruction for processing program setup. Once the processing program finished the editing, it then starts the processing program 15. Beyond this moment, Program node for judging the working instruction 16 will be used to determine: when the program node is a working instruction, it executes the working instruction 17, which is using the discharge-servo curve data of the internal record of the multiple discharge-servo curve controller to execute the cutting process, or when the program node isn't a working instruction, it will execute the program node for judging the discharge-servo curve instruction 18. Moreover, when program node is "discharge machining NO.n", access the discharge-servo curve data 19, which the n^{th} discharge-servo curve data will be accessed from the discharge-servo curve database and is then stored insider the multiple discharge-servo curve controller, wherein the "discharge machining NO.n" is called as the discharge-servo curve instruction. Otherwise, it will finish the processing when program node isn't the discharge-servo curve instruction. Conclusively, the discharge-servo curve instruction of the processing program

presents how to call the discharge-servo curve while the processing program is running. Therefore, this invention allow the operator to swap the different discharge-servo curve according with the real process requirement during the processing and to achieve the one-step process with arbitrarily choosing the multiple discharge-servo curve.

During the processing, the software control device is designed to control the discharge-servo curve, as shown in Figure 6, wherein this invented software control device comprises a human-machine interface unit 21, a multiple discharge-servo curve control device 22, an operation unit 23, an interpolation unit 24, a machine logic-control unit 25 and a motion unit 26, which the multiple discharge-servo curve control device 22 of the software control device controls the discharge-servo curve.

In Figure 7, this invented multiple discharge-servo curve control device of electrical discharge machine, which comprises a setting unit 221, a storage unit 222, a program unit 223, an instruction-judging unit 224 and a reading unit 225, wherein the storage unit 222 is used to store the discharge-servo curve data, the setting unit 221 is used to set the parameter value of the discharge-servo curve. Referring to the parameter value of the discharge-servo curve that is kept in the setting unit 221, read the discharge-servo curve data from the storage unit 222 by accessing through the reading unit 225. As far as the reading process is over, it will edit the working instruction and the discharge-servo curve

instruction of the processing program, then to start the processing program. However, the execution of the processing program will been executing with the discharge-servo curve data read from the reading unit 225. Whenever the processing program is started, the instruction-judging unit 224 will judge the program node is either a working instruction or a discharge-servo curve instruction. Using the discharge-servo curve instruction, which edited by the program unit 223, wherein it is called to swap the different discharge servo curve data according with the real process requirement during the processing program executing and to achieve the one-step process with arbitrarily choosing the multiple discharge-servo curve.

All of the aforementioned are only parts of collected better cases; it can't be defined to restrict this invention's claims. Furthermore, any modification and/or adjustment of this invention scope are still belonged to this document.